

Blentech corporation

P.O. Box 3109 Rohnert Park, CA 94927
707-523-5949 FAX 707-523-5939

VACUUM COOLING OPTION

Vacuum Cooling for BlenTherms and VersaTherms

Vacuum cooling is quick and inexpensive. It is extremely simple and reliable in operation requiring little maintenance. Typically, a 1000-lb (500-kg) batch is vacuum cooled from 185°F (100°C) to 40°F (5°C) in 45 minutes. The product is cooled evenly with little flavor lost in the cooling process.

Use of vacuum cooling in the food industry is well known and proven. Because it offers definite advantages over other methods of cooling, it has been employed for cooling many different types of products in industry for well over 20 years.

Two Basic Principles of Vacuum Cooling

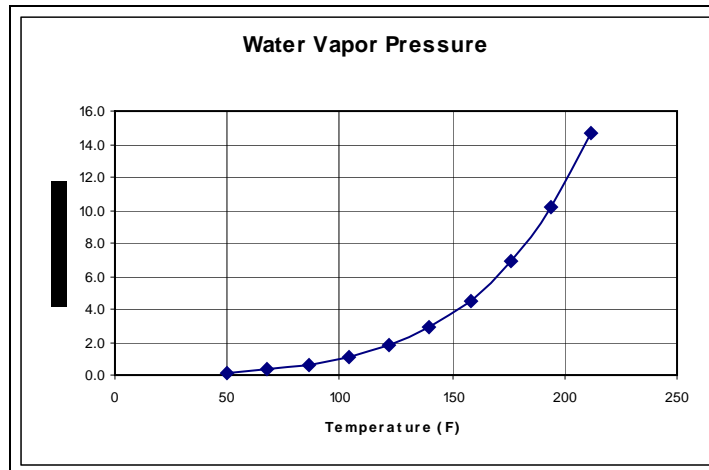
Two scientific principles are basic to this process:

1. Converting liquid to gas at atmospheric pressure

During the normal process of heating water, 1 BTU (1055 Joules) of heat energy is required to heat 1 lb (0.45 kgs) of water 1°F (0.55°C). However, when water at atmospheric pressure reaches its boiling point of 212°F (100°C), it begins to convert the liquid into gas. This process requires an enormous amount of additional heat. In fact, it takes approximately 1,000 BTUs to convert one pound of water-to-water vapor. It follows that if we force water to evaporate at lower temperatures, then we would essentially *boil* heat out of the product at the rate of 1,000 BTUs per pound of water evaporated.

2. Converting water to vapor at pressures lower than atmospheric

When the ambient pressure around a product is reduced to a level below the water vapor pressure for a given temperature, water will begin to boil. A basic example is pasta is cooked in a pot of boiling water in a rarified atmosphere or high altitude. Because water at the higher atmosphere will boil at lower temperatures, the pasta will take longer to cook. This relationship is defined by the Clausius-Clapeyron equation. In our cooling vessel, therefore, we lower the boiling point by removing air by drawing a vacuum.



Creating A Vacuum

To properly achieve a vacuum for chilling, we must remove both air and water vapor. These two gases differ in one very important respect:

- *Water Vapor* is condensable.
- *Air* is not condensable at temperatures normally achieved during food processing.

As with all condensable gases, when converted back to liquid, water reduces considerably in volume. If limited to a confined space it will create a vacuum. This characteristic of water vapor is used in our vacuum cooling system. By passing the water vapor and air extracted by the vacuum pump through a condenser, we can condense the water vapor back to a liquid, creating additional vacuum in the process. Effectively, therefore, the condenser acts as a booster for the vacuum pump.

Types of Condensers

Two types of condenser are commonly used:

- *Direct condenser* sprays cold water directly onto the water vapor and air passing beneath it.
- *Indirect condenser* passes the water vapor and air through a jacketed tube with the cold water passing through the center of the tube.

In either case, the condenser works in conjunction with a liquid ring vacuum pump. This style of vacuum cooling system works very well as product is cooled to around 95° - 104°F (35° - 40°C). At these temperatures, the temperature of our water vapor is nearing the temperature of our cooling water and slower condensation results. On a graph of temperature versus time we would see the graph flatten out dramatically as the product temperature approach 95° - 104°F.

Therefore, it is necessary to include a device to raise the temperature of our water vapor to boost the rate of condensation, and thereby to boost the power of our vacuum system. We do this with a Steam Ejector between the Cooling Vessel and the Condenser.

Steam Ejector

The Steam Ejector uses a jet of high-pressure steam to mix with the water vapor coming off the batch and to carry it through to the cooling water at a pressure high enough for it to be condensed at a rapid rate. It does this by means of a convergent-divergent tube (often called a Venturi tube). The ejector enables the vacuum pump to be effective even with cooling water in the condenser at temperatures as relatively high as 77° - 86°F (25° - 30°C). Although even greater vacuum can be achieved with cold cooling water.

Other Factors Affecting Vacuum Cooling

There are many different factors effecting the speed, efficiency and effects on the product being vacuum cooled including, surface area exposed to the atmosphere, specific heat of the product, viscosity, particle size in product and many more. The most rapid vacuum cooling occurs when a large surface area of product is exposed to the vacuum. A notable example is a flash evaporative cooler. This is not easily achieved in chillers and cook/chill vessels, which by their nature are normally deep vessels and is often limited in its ability to cool higher viscosity products.

VersaTherm and BlenTherm Increase Surface Area

Both the BlenTherm and VersaTherm are highly effective blenders, designed to handle even the most viscous products. In the both, the product is continuously exposed to the vacuum by rotating ribbon agitators during the chill cycle. Hotter pockets of product are rapidly cooled with as they are exposed to the vacuum to product interface. These cooled regions of product are then evenly mixed into the product transferring the chilling effect throughout the batch. When used in combination with jacket chilling, this process can be accelerated even further.